INNOVATIVE ACTIVITY, PRODUCTIVITY GROWTH, AND FIRM PERFORMANCE:
ARE LABOR UNIONS A SPUR OR A DETERRENT?

Barry T. Hirsch

I. INTRODUCTION

Factors limiting the appropriability of returns from innovative activity and capital investment are likely to affect the level and mix of investment and, in turn, have an impact on productivity levels and growth. Much previous research has focused on product market structure and other factors affecting the appropriability of the returns from R&D and patents. Only recently has attention has been given to the potentially important role of labor unions on various dimensions of economic performance. Neglect of unionism's potential role is surprising. U.S. labor law provides unions with varying degrees of monopoly power in

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the factor market, thus allowing union and nonunion labor to appropriate some share of firm quasi-rents. Unions typically have significant effects on the level, dispersion, and wage–fringe mix of labor compensation, as well as affecting productivity and governance structures in the workplace. Hence, it should not be surprising if the investment behavior and economic performance of unionized companies differ significantly from those of nonunion companies.

This paper examines the effects of labor unions on the investment behavior and economic performance of U.S. firms during the 1970s, with particular emphasis given to union effects on R&D investment, capital investment, and productivity. A model of union rent seeking is presented in which a portion of firm quasi-rents is appropriated by labor. The implications of union rent seeking are then examined, with emphasis given to a delineation between “direct” and “indirect” union effects on investment behavior, productivity, and productivity growth. Empirical evidence is based on a unique firm-level data sample representing the activities of U.S. manufacturing firms during the 1970s.

Substantial differences in investment behavior and economic performance between union and nonunion forms are found. Unionized companies invest significantly less in both R&D and physical capital than do similar nonunion firms. The union impact on these investments is both direct, resulting from union appropriation of investment returns, and indirect, resulting from lower profitability, which in turn raises the cost of funds. Unions are likewise found to impact negatively on firm productivity and productivity growth. These latter effects occur directly through union effects in the workplace, and indirectly through union effects on R&D and capital investment. These findings lead to two major conclusions: first, union effects on long-run firm performance are substantial and should not be ignored in studies examining investment behavior, technological change, and productivity growth; and second, the relatively poor performance of unionized companies during the 1970s helps to explain increased management resistance to union organizing and the declining importance of collective bargaining in the U.S.3

Section II of this paper presents the union rent-seeking framework employed in this study, focusing in particular on the impact of collective bargaining on firm investment decisions. In Section III, the data are described and descriptive evidence on firm performance variables is provided for companies with varying levels of union coverage. Section IV provides discussion of econometric specification and presents evidence, in turn, of union effects on R&D expenditures, capital
investment, productivity levels, and productivity growth. Section V offers an interpretation, and qualification, of the paper’s major findings. A summary follows in Section VI.

II. UNION RENT SEEKING, INVESTMENT, AND ECONOMIC PERFORMANCE

A. Static Models and the Bargaining Process

Labor unions and management bargain over the level and mix of pecuniary and nonpecuniary compensation, work conditions, and workplace governance structures. Management is assumed to maximize the value of the firm (the discounted stream of future earnings). The union maximand is less clear. It will use its bargaining power to acquire present and future contract provisions providing compensation—employment combinations for its members, more highly valued than those available in a competitive labor market. As discussed below, each party has a degree of monopoly or monopsony power, thus making short- and long-run bargaining outcomes indeterminate a priori. The parties engage in repeated bargaining (typically, every 3 years) and arrive at either cooperative (i.e., jointly maximizing) or noncooperative bargaining outcomes. It will be argued that in either case, company profits, investment decisions, productivity, and productivity growth will likely differ between union and nonunion firms.

Labor union monopoly power derives from a combination of U.S. labor law and the potential costs that a union can impose on a firm through a strike or other variation in labor input. In bargaining units where a union has won recognition under National Labor Relations Board auspices, it is the sole representative of workers in negotiations with management. Management must bargain in “good faith” with the union, but it is not required to arrive at a contractual agreement. Because it is costly for a firm not to reach an agreement or to substitute a nonunion work force, the union has some degree of monopoly power in the labor market. Union bargaining strength is of course limited by the level and elasticity of the labor demand curve (although settlements need not be on the demand curve) or, more specifically, by the substitution capabilities of consumers and management and by the legal rules and enforcement surrounding the NLRB union representation process. Firm monopsony power results primarily from the fixed costs to workers of job change and the fact that employees possess firm-
specific skills not easily transferred to other firms. One can make similar arguments about industry-specific skills that are difficult for workers to transfer in the event of industry-wide employment downturns.

Much of the literature on bargaining outcomes has employed a single-period model and contrasted the properties of settlements on the labor demand curve with Pareto-superior settlements off the labor demand curve. The conventional bargaining model predicts outcomes on the labor demand curve following sequential wage and employment determination. The union is constrained by the labor demand curve (i.e., it faces a wage—employment tradeoff) and "selects" a wage above the competitive wage that maximizes union rents, commonly defined as \((w_u - w_c)L\), where \(w_u\) is the union wage, \(w_c\) is the (unobserved) competitive wage, and \(L\) is employment. The firm is free to vary employment at the union wage, and maximizes profits by selecting the employment level on its labor demand curve corresponding to \(w_u\).

Bargaining outcomes on the labor demand curve, however, are generally not Pareto-optimal. There exist outcomes in wage—employment space to the right of the labor demand curve, at a lower wage and higher employment level than at the union's obtainable outcome on the demand curve, preferred by both the union and firm; that is, corresponding to higher union utility and firm profit. The range of "efficient" bargaining outcomes is defined by a contract curve, derived from the tangencies between the union's indifference curves and the firm's isoprofit curves. The contract curve can in general take on a positive or negative slope, but in the unique "strong efficiency" case (Brown and Ashenfelter, 1986) it is vertical at points above \(w_c\) in wage—employment space. Bargaining outcomes on a vertical contract curve would imply the use of a factor mix identical to the (short-run) competitive case. In essence, the union and firm agree to maximize the joint value of the enterprise, comprised of the sum of firm profits and union rents, and subsequently bargain over the division of the surplus between profits and wages (Abowd, 1987).

The existence of preferred bargaining outcomes off the labor demand curve does not ensure that such outcomes are obtainable. In order to achieve such an outcome there must be explicit or implicit contracting that allows for simultaneous bargaining over wages and employment. Stated alternatively, there must be some mechanism that forces the firm to have a greater employment level than designated by the demand curve. Otherwise, following contract agreement on the wage, the firm would select an employment level to maximize profits,
thereby obtaining an outcome on the labor demand curve. While labor contracts containing explicit employment requirements are rare, stable long-run repetitive bargaining and union work rules may allow the obtaining of efficient outcomes by preventing the firm from engaging in opportunist behavior. Extant empirical evidence, albeit limited, rejects the hypothesis of bargaining outcomes on a labor demand curve, but it is not necessarily supportive of the hypothesis of settlements on a vertical contract curve (Hirsch and Addison, 1986; Farber, 1986).

The primary limitation of the conventional on-the-demand curve and off-the-demand curve models is that they are static single-period models applied in situations where repetitive bargaining, reputational "capital," and evolved protocols (Reder and Neumann, 1980) are essential elements of the bargaining process. While the off-the-demand curve model relies on the existence of repeated bargaining to ensure that the firm does not behave opportunistically (i.e., hire at an employment level on the demand curve once the wage is determined), the strong efficiency result described above holds only in the short run. Joint profits and union rents are maximized, given the level of the capital stock. In the long run, union rent seeking will be distortionary if firms respond by altering their investment in tangible and intangible capital. It is this possibility to which we now turn.

B. Union Rent Seeking and Dynamic Bargaining Models

Recent papers have provided diverse theoretical models of the union bargaining process in a dynamic setting. Here, an intuitive discussion of a game-theoretic model, referred to here as a union rent-seeking model, is provided. Outlined first will be the nature of bargaining with noncooperative outcomes. Examined next will be the effects of bargaining with cooperative outcomes. The union rent-seeking framework outlined in this paper relies on several assumptions: the firm has, or would have in the absence of a union, long-lived intangible or physical capital providing quasi-rents; the firm cannot costlessly substitute nonunion for union labor (or plants); and the time horizon over which the union evaluates its utility is shorter than the horizon over which firm owners evaluate earnings (or, similarly, the union discounts more highly than the firm future returns). Each of these assumptions is reasonable. Once innovative capital or physical capital (often emanating from past R&D) is in place, its productive life typically exceeds the life of a union contract. The union
strike threat, made possible by legal bargaining rights granted to unions and to workers' possession of firm-specific skills, makes it costly for firms to substitute nonunion for union labor. The union is also likely to have a limited time horizon. Whereas owners will in general have an unlimited time horizon since ownership shares can be transferred (albeit the future may be highly discounted), union members are unable to sell or transfer their positions in the union.

Consider first the case of a noncooperative bargaining outcome. Once long-lived capital is in place, the union will appropriate or tax some share of the quasi-rents deriving from that capital. As long as the union maintains a credible strike threat and the firm can recover its variable costs, the firm will "voluntarily" share with the union its returns on capital rather than severely curtail production. The firm is likely to face higher union "tax" rates on innovative and physical capital the more firm specific is the capital and the longer is its productive life. In response to the union tax, the firm will reduce its investment in long-lived capital until the postunion marginal rate of return is equal to the opportunity costs of funds (the union places a wedge between the social and private rates of return on capital). Investment in all forms of vulnerable capital will decrease; the limiting case is that the firm will cease investment and eventually shut down its union operations. Alternatively, the firm may always maintain some inefficient capital (or plants) to mitigate union wage demands, since the firm would respond to high wages by shutting down low productivity plants, thus decreasing union employment (see Baldwin, 1983).8

As long as bargaining occurs for a limited number of bargaining rounds, union appropriation of firm quasi-rents and a reduction in investment activity will occur. A union could announce a relatively low future wage demand in order to encourage the firm to invest in long-lived capital. But the union's commitment would be neither credible nor binding beyond the contract period, since once the capital is in place the union would increase its wage demands in the final bargaining period. Knowing this, the firm would not commit to a nonunion investment level.9 In short, as long as there are a limited number of bargaining periods, noncooperative bargaining outcomes are likely to obtain.

Collective bargaining, however, is generally characterized by infinitely repeated bargaining, the exception being where a firm is expected to shut down operations.10 Repeated bargaining implies that current behavior by both the firm and union will affect their reputation and credibility in future bargaining rounds. Because the scope for
opportunistic behavior is limited, cooperative bargaining outcomes are more likely to obtain. A cooperative outcome is defined here as one that maximizes the joint value of the firm and union; that is, the sum of the firm’s market value (the present value of future earnings to shareholders) and the present value of union members’ rents [this joint value is referred to by Abowd (1987) as the value of the enterprise].

Does the possibility of cooperative outcomes from repeated union-management bargaining imply that union representation has no distortionary effects on output, price, or factor usage? This is the case in the short run; the firm and union maximize the size of the pie, given the existing capital stock, and bargain over the distribution of returns to labor and to shareholders. In the long run, however, union rent seeking will be distortionary (relative to an otherwise similar nonunion environment); in particular, it is likely to lead to reduced investment in long-lived relation-specific capital.

The reason for underinvestment in specific fixed-cost capital is the limited time horizon over which a democratically controlled labor union evaluates its future returns, coupled with the nontransferability or incomplete property rights union workers have in union membership. The union responds to the preferences of members with median preferences, often relatively senior members with a relatively short expected remaining tenure at the firm. Moreover, senior workers may make relatively high wage demands if they face relatively low probabilities of permanent (seniority-based) layoff and perceive little threat to their pension payments (government pension guarantees, although perhaps warranted on other grounds, presumably worsen union myopia). Largely unweighted in the union calculus are preferences of relatively junior members or of unobserved workers who could be future union members were the union’s compensation demands lower. Thus, the union will weight highly current rents and discount heavily potential future rents. Although efficient (cooperative) contracting maximizes the sum of owner and union member “wealth,” rational union myopia will result in lower investment than is obtained in a nonunion firm, shifting returns more heavily toward the present and away from the (highly discounted) future. And apart from the partial transfer of stock ownership to the union, there are few mechanisms by which to make union goals more fully incentive-compatible with those of the firm.

The union rent-seeking model predicts that collective bargaining coverage fundamentally changes investment decisions because the firm responds to a rationally myopic union by decreasing investment in
vulnerable capital. Contrary to the prediction of the conventional on-the-demand curve model, firms facing a rent-seeking union may decrease both the capital level and the capital–labor ratio. In the case of heterogeneous capital, the firm will decrease investment most in long-lived relation-specific capital whose returns are most easily appropriated, while either increasing or decreasing investment in capital whose returns are less easily appropriable. Even the prediction that unionized firms will invest relatively more than nonunion firms in labor-saving capital need not follow. If the union can retain its preinvestment strike threat with a reduced work force (say, through the ability to shut down a plant), then the returns from labor-saving capital are no less appropriable than those from factor-neutral investment. Indeed, the union may demand higher per employee compensation and/or employment guarantees if the firm embarks on a labor-saving investment strategy. Of course, if the union strike threat and bargaining power is in part a function of the size of its work force, then the prediction that unionized firms’ investment will be labor saving follows more readily.

The returns from investment in R&D and non-R&D innovative activity may accrue over a shorter time span than returns from physical capital, but such capital is still relatively long lived and appropriable (Connolly et al., 1986). Or, the knowledge about products or processes emanating from R&D projects may lead to investment in physical capital whose returns in turn face a high union tax rate. That is, the decision to lower future investment in physical capital may decrease current investment in R&D. For these reasons, unionized firms are less likely to invest in innovative activity than are similar nonunion firms. This decrease in innovation is likely to be most notable for relatively factor-neutral product or process innovation, whereas labor-saving process innovation may be less affected, since the substitution effect of a wage increase may increase the relative importance of labor-saving innovation.¹⁴

Firms are often reluctant to patent and license innovative processes resulting from R&D and other investment in innovation, because the process by which firms patent and sell licenses is costly, risky, and often revealing of trade secrets. Innovations that can be licensed are less likely to be subjected to the union strike threat and rent seeking, however, because the returns from patentable innovations do not depend on continued plant operations. Hence, unions may be less able to capture returns associated with patentable innovations, and union firms should have a higher propensity to patent, given levels of innovative activity.
Finally, if union rent seeking results in decreased investment in tangible and intangible capital, an implication is that unionized firms will be less productive, face slower productivity and sales growth than otherwise similar nonunion firms, and, relatedly, are less likely to survive in the long run. Output is a function of random components, input quantity, input quality, and the organization and coordination of production and managerial processes. Union rent seeking operates indirectly to reduce measured productivity (i.e., value added per worker) or productivity growth through reduced investment in R&D and other forms of capital. Whether or not unions have direct effects, that is, whether union firms have different productivity levels or growth rates than nonunion firms, holding constant stocks (or changes in stocks) of R&D and physical capital, is an important yet distinct question to be addressed below.

From our model of union rent seeking, wherein unions tax the quasi-rents that make up the normal returns to long-lived tangible and intangible capital, several empirical regularities are expected to appear in the data. First, union firms should experience lower rates of profit than otherwise similar nonunion firms. And even in the event of cooperative or efficient long-run contracting between firms and relatively myopic unions, the union tax on profits is likely to be distortionary and lower investment in capital whose returns are most vulnerable to union appropriation. We expect to observe lower investment by union firms in physical capital and R&D, as well as the possibility of lower capital-to-labor ratios and a higher propensity to patent, given levels of innovative activity. Lower investment in long-lived tangible and intangible capital will subsequently retard productivity and productivity growth. The possibility that unions directly affect productivity and productivity growth, independent of their effects on R&D and capital investment, also will be examined.

III. DATA AND DESCRIPTIVE EVIDENCE

The data set employed in this paper is based on information from 315 publicly traded Fortune 1000 firms operating in the U.S. manufacturing sector in the 1970s for which information both on firm-level union coverage and financial data from Standard and Poor's Compustat files are available. Annual Compustat data for 1970 through 1980 are used; union coverage data are available only for 1972. Missing data for some variables result in the exclusion of some "firm-years" from various analyses.
An important empirical contribution of this paper is the use of firm-level, rather than industry-level, data on union coverage. Previous firm-level studies of market value or investment behavior (Salingger, 1984; Connolly et al., 1986; Hirsch and Connolly, 1987; Bronars and Deere, 1986) have had to match three-digit industry-level union data to individual firm observations. Hence, these studies have not been able to account for the considerable intraindustry variation in unionization, and may have entangled to a significant degree union and industry effects on market value and investment. The firm-level union data employed here are for a single year, 1972, and were obtained from a 1972 Conference Board Survey. The primary union data measure the percentage of production and maintenance workers covered by a collective bargaining agreement. Because we are interested in the extent of unionization within the entire firm and firms vary in the proportion of their work force comprised of production workers, this coverage ratio is multiplied by the estimated proportion of production workers in the firm. This conversion is based on the assumption that there exists zero coverage among nonproduction workers; coverage among such workers causes the total firm coverage estimates to be understated. Mean union coverage for our sample of firms in 1972 is 43.6% of the total work force, as compared to 58.9% of production and maintenance workers.

The second primary data set, constructed at the National Bureau of Economic Research and Harvard University, matches Compustat company information with U.S. patents data from the Office of Technology Assessment and Forecasting. The initial universe was all publicly traded firms in the manufacturing sector that were listed on any of four Compustat files (Industrial, Over the Counter, Research, or Full Coverage files) in 1976. Information from years prior to and following 1976 is included to provide an unbalanced panel data set with a maximum 1904 firms in 1976 and fewer in other years, 315 for which union coverage information is available in the Conference Board Survey. Company 10-K reports filed with the Securities and Exchange Commission provide the source for much of the information on Compustat. This data set contains relatively complete information on firm market values, earnings, gross and net plant, the book value of debt, R&D investment, and patents (filed and granted). Less complete data are available for advertising expenditures and labor compensation. Industry data are matched to the firm at the two-, three-, or four-digit level, based on Compustat's SIC-code variable designating the firm's principal industry. Industry data on shipments, capital intensity, the
ratio of production to total employees, and investment are obtained from the Bureau of Industrial Economics Industrial Profile and Capital Stock Data Base tapes consolidating data from the Annual Survey of Manufactures. Data on industry concentration (adjusted for imports and regional concentration), as well as import penetration, are available for 1972 and 1977 from Weiss and Pascoe (1986).

Prior to estimation of the investment, productivity, and productivity growth models, it is useful to examine differences in key firm-level economic performance variables by firms’ union status. In Table 1, we

<table>
<thead>
<tr>
<th>Variable</th>
<th>All Firms</th>
<th>Low union</th>
<th>Medium union</th>
<th>High union</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
<td>n</td>
<td>Mean</td>
</tr>
<tr>
<td>COV</td>
<td>3410</td>
<td>0.436</td>
<td>1112</td>
<td>0.084</td>
</tr>
<tr>
<td>q</td>
<td>3260</td>
<td>1.076</td>
<td>1079</td>
<td>1.518</td>
</tr>
<tr>
<td>( \pi_k )</td>
<td>3257</td>
<td>0.076</td>
<td>1078</td>
<td>0.090</td>
</tr>
<tr>
<td>R&amp;D/S</td>
<td>2407</td>
<td>0.021</td>
<td>805</td>
<td>0.030</td>
</tr>
<tr>
<td>PAT/S</td>
<td>2902</td>
<td>0.045</td>
<td>942</td>
<td>0.055</td>
</tr>
<tr>
<td>INV/S</td>
<td>3289</td>
<td>0.061</td>
<td>1084</td>
<td>0.067</td>
</tr>
<tr>
<td>ADV/S</td>
<td>1928</td>
<td>0.021</td>
<td>675</td>
<td>0.031</td>
</tr>
<tr>
<td>K/S</td>
<td>3262</td>
<td>0.717</td>
<td>1079</td>
<td>0.652</td>
</tr>
<tr>
<td>ln(VA/L)</td>
<td>3274</td>
<td>3.015</td>
<td>1082</td>
<td>3.076</td>
</tr>
<tr>
<td>( \rho_t )</td>
<td>2002</td>
<td>0.014</td>
<td>671</td>
<td>0.026</td>
</tr>
<tr>
<td>DEBT/EQUITY</td>
<td>3249</td>
<td>0.503</td>
<td>1075</td>
<td>0.543</td>
</tr>
<tr>
<td>CR4</td>
<td>3410</td>
<td>0.397</td>
<td>1112</td>
<td>0.413</td>
</tr>
<tr>
<td>I-IMPORT</td>
<td>3410</td>
<td>0.071</td>
<td>1112</td>
<td>0.071</td>
</tr>
<tr>
<td>I-GROWTH</td>
<td>3410</td>
<td>3.096</td>
<td>1112</td>
<td>4.320</td>
</tr>
</tbody>
</table>

*Low union (COV < 0.28); medium union (0.28 ≤ COV < 0.63); high union (COV ≥ 0.63).

COV: Proportion of firm’s workers covered by a collective bargaining agreement.
q: Market value of firm divided by replacement cost of tangible assets (measured by value of net inflation-adjusted capital stock).
\( \pi_k \): Gross rate of return to capital; gross cash flows divided by the value of the gross inflation-adjusted capital stock.
R&D/S: Annual R&D expenditures divided by sales.
PAT/S: Patent stock (calculated based on number of patents granted and a 30% depreciation rate) divided by sales.
INV/S: Annual investment expenditures divided by sales.
ADV/S: Annual advertising expenditures divided by sales.
K/S: Net inflation-adjusted capital stock divided by sales.
DEBT/EQUITY: Value of long-term debt adjusted for age structure, divided by equity value of firm.
ln(VA/L): Natural log of value added per employee, in millions of 1972 dollars. (See Appendix and footnote 21.)
\( \rho_t \): Partial productivity growth, calculated as the average annual 4-year growth rate in value added, minus the average annual growth rate in employment times labor’s share of total costs (See Appendix and footnote 21.)
CR4: Four-firm concentration ratio in firm’s primary four-digit industry
I-IMPORT: Percentage of imports in firm’s primary four-digit industry
I-GROWTH: Average percentage growth rate in real industry shipments over the previous 4 years in firm’s primary four-digit industry.
present means and standard deviations for variables of interest, separately for the entire sample over the 1970–1980 period (growth rates are for 1970–1974 through 1976–1980), and for the 315 firms (for a maximum of 11 years) divided into approximately equal-sized groups of low (n = 103), medium (n = 110), and high (n = 102) union coverage levels, COV ("low" is defined as COV < 0.28, "medium" as 0.28 ≤ COV < 0.63, and "high" as COV ≥ 0.63). Within the low union sample, 31 of the firms have zero coverage and 65 have less than 10% coverage. These 96 firms are defined as "nonunion" in subsequent regression analyses. Because of missing data, particularly for years after 1976 as firms "leave" the sample due to mergers, going private, or dissolutions, total sample sizes in Table 1 are less than 11 times 315 (or 7 times 315 for the growth rates). Variable definitions are provided in the footnote to Table 1.

A number of interesting patterns are evident from these descriptive statistics. The low union sample of firms has an average coverage of 8.4%, as compared to 47.1 and 75.1% for the medium and high union samples, respectively. The existence of union rent seeking is suggested by the finding that as firm union coverage increases, profitability is substantially lower, whether measured by Tobin’s q or \( \pi_k \).\(^{19}\) Market valuation of the firm (as measured by q) drops particularly sharply as one moves from low to middle union coverage, suggesting that even moderate levels of unionization significantly reduce investors’ expectations of future shareholder earnings.

Capital intensity, as measured by the capital stock per worker, K/S, increases moderately with union coverage. Firms with higher coverage, however, have lower capital investment intensities—the ratio of capital investment to sales (INV/S) decreasing as one moves from low to high coverage firms. R&D investment intensity (R&D/S) is also found to decrease as union coverage increases, differences being particularly large between the low union and medium/high union categories.\(^{20}\) New patents per dollar of (deflated) sales (PAT/S) also declines with union coverage, although here the difference is largest between the high union and other two union groups. We find a U-shape relationship between firms’ debt–equity ratios, DEBT/EQUITY, and union category, the debt–equity ratios being higher in both the low and high union samples than in the middle union sample. Just over half of the sample report advertising expenditures, but among these firms, advertising intensity (ADV/S) decreases sharply as we move from low to high union coverage (a similar pattern is evident if nonreporting firms are assumed to have zero advertising).
Labor productivity, measured by the logarithm of value added per worker, is about 8% lower among medium/high union firms than among companies with low union coverage.\textsuperscript{21} “Partial” productivity growth (Griliches, 1986), measured by the average annual 4-year growth rate in value added, minus the growth rate in employment times labor’s share, is substantially higher among the low union companies, about 2.6% annually as compared to less than 1% among medium/high companies. And in results not shown, average growth rates in employment, capital, and R&D all decrease with respect to union coverage.

Differences in industry concentration, CR4, and industry import penetration, I-IMPORT, exhibit less clear-cut patterns with respect to firms’ union coverage. Industry sales growth, I-GROWTH, however, decreases sharply as we move from the low to high union category, indicating that union firms are located within four-digit industries with significantly slower growth. The sizable differences seen above between the economic performance of companies with low and high levels of union coverage demonstrate the need for careful empirical analysis. In the remainder of the paper, we seek to identify the extent to which differences in investment behavior, productivity, and productivity growth can be attributed to differences in union coverage.

\section*{IV. EMPIRICAL SPECIFICATION AND RESULTS}

This section presents empirical analysis examining the impact of unionization on firm investment behavior, innovative activity, productivity, and productivity growth. We first examine firm investment in R&D and physical capital, distinguishing between direct and indirect impacts of union coverage on investment behavior. Next, differences in productivity levels and productivity growth between union and non-union firms are examined. Detailed variable definitions are provided in the Appendix; a further description of variables is in the text.

A. Union Coverage, Innovative Activity, and Capital Investment

The union rent-seeking model predicts differences between the investment behavior of union and nonunion firms. Primary attention is given here to differences with respect to investments in physical capital and R&D, the latter being a proxy for innovative activity. Because we are interested in how unionism affects current investment behavior, we
focus on investment flows or additions to the stock of physical or R&D capital (capital stocks are controlled for on the right-hand side of equations). Investment intensity equations take the simple form:

\[ I_{it} = \Sigma \beta_{lk} X_{kit} + \psi_I UN + e_{lit} \]  

(1)

where \( I_{it} \) represents the natural logarithm of investment in physical capital or R&D by firm \( i \) in year \( t \), \( I \) indexes investment vectors, and \( e_{lit} \) is a random error term with zero mean and constant variance. \( X_I \) is a vector of \( k + 1 \) firm- and industry-specific variables, including a constant \((X_0 = 1)\), that affect investment, while \( \beta_{lk} \) is the coefficient vector attaching to \( X \). In this and subsequent regression models, union coverage status, \( UN \), enters separately (i.e., not in interaction with other variables) as a categorical union/nonunion variable, equal to zero if union coverage is less than 10% and equal to one if coverage is at least 10%. Experimentation indicated that most union effects occur at relatively low coverage levels, but do not necessarily increase with increasing coverage (see, also, Clark, 1984). Conclusions are similar when continuous union coverage or multiple categorical variables are used.

Included in \( X_I \) are such variables as contemporaneous profitability (measured by the rate of return on capital), firm size, capital intensity, R&D and/or capital stock variables, industry concentration, industry sales growth, industry import penetration, and industry and year dummies. The coefficient \( \psi_I \) measures the direct partial effect of union coverage on investment. The total union effect will also include indirect effects on investment deriving from lower earnings in union firms. Auxiliary profit equations are estimated in order to estimate the magnitude of these indirect union effects on investment behavior.

Table 2 presents regression results for R&D and capital investment equations. The dependent variable in the R&D equations is the logarithm of real annual investment expenditures on R&D, \( \ln(R&D) \). Specifications are presented with and without inclusion of industry dummies. As control variables, we include current profitability (measured by the rate of return on capital), an R&D stock variable, the log of real sales, the log of the capital stock, industry concentration, industry sales growth, industry import penetration, and year dummies. The R&D investment equations are reported for the sample of R&D-active firms reporting positive R&D expenditures \((n = 2382)\), and for a larger sample where nonreporting firms for which patent data are available
Table 2. R&D and Capital Investment Equations—Regression Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>ln(R&amp;D)</th>
<th>ln(R&amp;D)\textsuperscript{est}</th>
<th>ln(INV)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>UN</td>
<td>-0.140</td>
<td>-0.100</td>
<td>-0.102</td>
</tr>
<tr>
<td></td>
<td>(4.47)</td>
<td>(2.94)</td>
<td>(3.65)</td>
</tr>
<tr>
<td>π\textsubscript{k}</td>
<td>2.723</td>
<td>2.283</td>
<td>2.200</td>
</tr>
<tr>
<td></td>
<td>(8.60)</td>
<td>(7.42)</td>
<td>(7.85)</td>
</tr>
<tr>
<td>ln(L)</td>
<td>0.273</td>
<td>0.215</td>
<td>0.190</td>
</tr>
<tr>
<td></td>
<td>(10.95)</td>
<td>(7.09)</td>
<td>(9.26)</td>
</tr>
<tr>
<td>ln(K)</td>
<td>0.116</td>
<td>0.325</td>
<td>0.088</td>
</tr>
<tr>
<td></td>
<td>(5.67)</td>
<td>(11.29)</td>
<td>(5.14)</td>
</tr>
<tr>
<td>R&amp;D-STK\textsuperscript{est}(-1)</td>
<td>0.672</td>
<td>0.519</td>
<td>0.745</td>
</tr>
<tr>
<td></td>
<td>(55.70)</td>
<td>(38.40)</td>
<td>(69.81)</td>
</tr>
<tr>
<td>R&amp;D-STK\textsuperscript{est}</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>ln(K)(-1)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CR4</td>
<td>-0.047</td>
<td>-0.259</td>
<td>0.071</td>
</tr>
<tr>
<td></td>
<td>(0.64)</td>
<td>(2.85)</td>
<td>(1.11)</td>
</tr>
<tr>
<td>I-GROWTH</td>
<td>0.012</td>
<td>0.010</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>(5.18)</td>
<td>(3.97)</td>
<td>(5.87)</td>
</tr>
<tr>
<td>I-IMPORT</td>
<td>0.287</td>
<td>0.095</td>
<td>0.347</td>
</tr>
<tr>
<td></td>
<td>(1.63)</td>
<td>(0.50)</td>
<td>(2.16)</td>
</tr>
<tr>
<td>IND</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>YEAR</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R\textsuperscript{2}</td>
<td>0.877</td>
<td>0.897</td>
<td>0.865</td>
</tr>
<tr>
<td>n</td>
<td>2382</td>
<td>2382</td>
<td>3001</td>
</tr>
</tbody>
</table>

\(a\)\(t\) in parentheses.

are assigned predicted values of R&D stocks and investment expenditure (n = 3001).\(^22\)

Primary interest here centers on the coefficients associated with firm union status, measuring the direct union effect, and π, allowing estimation of an indirect effect. Estimates of the direct union effect on R&D investment indicate that unionized firms have R&D investment 9–10% lower than otherwise similar nonunion firms, after accounting for other firm and industry determinants of R&D. Estimates from the two samples are very similar. Estimates of the direct effect of unionism understate unionism's total effect, however, because union rent seeking also decreases investment indirectly owing to lower firm earnings that impinge upon all investment decisions. In an auxiliary profit equation (where profitability is measured by the rate of return on capital,
\( \pi \), the partial effect of union coverage on \( \pi \) is estimated to be \( \partial \pi / \partial \text{UN} = -0.018 \). Hence the total effect of unionism on R&D investment is:

\[
d\ln \text{R&D}/d\text{UN} = \partial \ln \text{R&D}/\partial \text{UN} + (\partial \ln \text{R&D}/\partial \pi)(\partial \pi/\partial \text{UN})
\]

\[
= -0.088 + (1.764 \times -0.018) = -0.120
\]

(2)

where \( \partial \ln \text{R&D}/\partial \text{UN} \) and \( \partial \ln \text{R&D}/\partial \pi \) are obtained from the coefficients on UN and \( \pi \) in Table 2, specification (4), and the estimate of \( \partial \pi/\partial \text{UN} \) is obtained from the UN coefficient in a profitability regression, not shown.\(^{23}\) Thus, the estimates imply that unionized firms will have R&D investment about 11% lower than similar nonunion firms (percentage effects are approximated by \([e^\lambda - 1]100\), where \( \lambda \) is the estimated logarithmic differential). Approximately three-quarters of the effect is a direct union effect, while a quarter of the effect occurs indirectly via union effects on firm earnings.

Union rent seeking is expected to affect tangible capital investment in a manner similar to R&D investment. Moreover, capital investment is an important mechanism by which technological change is effected. Capital investment is both complementary to investment in innovative activity, and has an important impact on subsequent productivity levels and growth. Table 2, columns (5) and (6), presents regression results from the estimation of capital investment equations where the log of annual real investment expenditures, \( \ln(\text{INV}) \), is the dependent variable. Unionization is negatively and significantly related to capital investment, decreasing investment directly (through its tax on the gross rate of return to investment), and indirectly through the decrease in earnings that provide a source of relatively low-cost financing. We estimate the total effect of unions on annual capital investment as

\[
d\ln \text{INV}/d\text{UN} = \partial \ln \text{INV}/\partial \text{UN} + (\partial \ln \text{INV}/\partial \pi)(\partial \pi/\partial \text{UN})
\]

\[
= -0.102 + (5.720 \times -0.018) = -0.205
\]

(3)

where \( \partial \ln \text{INV}/\partial \text{UN} \) and \( \partial \ln \text{INV}/\partial \pi \) are obtained from the coefficients on UN and \( \pi \) in Table 4, specification (6), and the estimate of \( \partial \pi/\partial \text{UN} \) is obtained as previously. The estimates imply that unionized firms will have capital investment about 18.5% lower than nonunion firms. Approximately half of the effect is a direct union effect, while the remaining half is an indirect union effect deriving from the decrease in current firm earnings.

The evidence presented in this section provides strong evidence that union rent seeking has significant real effects on firm investment behav-
ior. Cooperative bargaining outcomes between unions and firms potentially can be reached, implying no real allocative effects, given existing stocks of tangible and intangible capital. The relatively shorter time horizon adopted by union rank-and-file than among the firm's shareholders, however, implies reduced investment in long-lived fixed-cost capital even where cooperative outcomes obtain. Noncooperative bargaining outcomes typically imply even larger reductions in investment. The finding that unionized firms invest significantly less in R&D and physical capital than do nonunion firms implies that union firms and sectors will grow more slowly over time than their nonunion counterparts. Lower investment may also have an impact on long-run levels of productivity and productivity growth among unionized firms. We next turn to this topic.

B. Unions, Productivity, and Productivity Growth

Unions may have positive or negative direct effects on levels or changes in productivity, holding constant labor and nonlabor inputs. In addition, unionization will have an indirect impact on productivity levels and growth to the extent that it affects investment in tangible and intangible capital inputs. The traditional view of unions by economists portrays unions as a labor market distortion directly retarding productivity and growth. Negative union effects result from union work rules, limitations on management discretion and flexibility in promotions and job assignments, and decreased individual worker incentives due to limitations on merit-based wage dispersion.

Recent interest in union effects in the workplace was sparked by Freeman and Medoff's collective voice/institutional response (CV/IR) view of unions (Freeman, 1976; Freeman and Medoff, 1984). This view emphasizes the potential positive role of unions on economic performance in work environments characterized by long-run attachment of workers and firms, typically owing to large investment in firm-specific on-the-job training, worker complementarities in production (i.e., reliance on teamwork in production and training), and significant workplace "public" or nondivisible goods (e.g., job safety, personnel policies, hours of operation).24 It is argued that reliance on individual bargaining and entry/exit behavior as the primary instruments for worker voice is inefficient in such an environment. Unions provide a potential mechanism for correcting this "market failure," because a collective voice representing median or average workers may more accurately represent the preferences of the work force and de-
crease turnover. Worker cooperation and morale may be improved from the adoption of more formalized governance structure and grievance procedures, by lessening wage dispersion through use of standardized wages and strict reliance on seniority, and from restrictions on management’s ability to take unilateral actions without consideration of worker preferences.

Cooperative labor–management relations are necessary for unions to have positive productivity effects, hence the institutional response component of the CV/IR view. Given scant attention in the CV/IR literature is the possibility that nonunion firms may provide formalized governance structures that serve as instruments of worker voice, while not being encumbered by the higher costs or other negative effects of unions. Recent evidence that large nonunion establishments have highly formalized governance structures and provide mechanisms for worker input, while avoiding many of the costs associated with unions, suggests that unions are not always a necessary condition for establishing effective voice (Foulkes, 1980; Kochan et al., 1986). Indeed, increased use of “positive labor relations” by firms in nonunion plants, wherein workers are provided with many of the advantages of unionization, can be seen as a response to the threat of union organizing.

The empirical literature examining union effects on productivity typically follows Brown and Medoff (1978) in employing some variant of the Cobb–Douglas production function

\[ Q = AK^\alpha(L_n + cL_u)^{1-\alpha}, \]  

(4)

where \( Q \) is output, \( L_u \) and \( L_n \) are union and nonunion labor respectively, \( K \) is capital, \( A \) is a constant of proportionality, and \( \alpha \) and \( (1 - \alpha) \) are the output elasticities with respect to capital and labor, respectively. The parameter \( c \) measures productivity differences between union and nonunion labor. A \( c > 1 \) implies union labor is more productive, in line with the CV/IR view; a \( c < 1 \) implies union labor is less productive, in line with the traditional view. Brown and Medoff show that Eq. (4) can be approximated by the following (ignoring the error term),

\[ \ln(Q/L) = \ln A + \alpha \ln(K/L) + (1 - \alpha)(c - 1)P, \]  

(5)

where \( P \) represents union density (\( L_u/L \)).

Equations (4) and (5) assume constant returns to scale, an assumption that may be relaxed by including a \( \ln L \) variable as a measure of
establishment size. The productivity differential of unionized establishments is estimated by the composite coefficient on \( P \). If it is assumed that the union productivity effect solely reflects the differential efficiency of \( labor \) inputs, the union labor productivity effect is calculated by dividing the coefficient on \( P \) by \((1 - \alpha)\). Note also that estimation of (5) is similar to estimation of a total factor productivity (TFP) equation; \( c > 1 \) implies that unions have higher TFP. That is, subtracting \( \alpha \ln(K/L) \) from both sides of (5),

\[
\text{TFP} = \ln Q - \alpha \ln K - (1 - \alpha) \ln L = \ln A + (1 - \alpha)(c - 1)P.
\]  

(6)

More recently, the debate over union effects on productivity has shifted to union effects on productivity growth. Hirsch and Link (1984) show that changes in total factor productivity, \( \rho \), derived by differencing the Brown–Medoff model above, is a function of changes in union density, \( \Delta P \). Following the productivity growth literature emphasizing the role of R&D on growth, Hirsch and Link employ a Cobb–Douglas function that includes a third factor, technical capital (\( T \)). Their estimating equation (ignoring control variables) is

\[
\rho = \theta + \Phi(dT/dt)/Q + (1 - \alpha)(c - 1)\Delta P,
\]  

(7)

where \( \theta \) is the rate of disembodied growth; \( \Phi \) is \( \partial Q/\partial T \), the marginal product of technical capital, \( dT/dt \) approximates net investment into stock \( T \), and \( (dT/dt)/Q \) is proxied as R&D investment per unit of sales. A positive coefficient on \( \Delta P \) implies \( c > 1 \) and would support the CV/IR view. Estimating the production function in difference form (i.e., a simple form of a fixed effects model) has the advantage of netting out unmeasured or omitted determinants of productivity whose omission from single cross-section estimates may bias coefficients, but has the disadvantage that measures of changes in unionization are rarely available over suitably long time periods. In their empirical work, Hirsch and Link include both a level of unionism variable, \( P \), and a change in unionism variable, \( \Delta P \), for two-digit manufacturing industries.

Several limitations attach to the production function test (Addison and Hirsch, 1989). First, the use of value added as the output measure confounds price and quantity effects, since part of the measured union productivity differential may result from higher prices in unionized sectors. Quantity can be measured in physical units in industry-specific
studies, but union effects vary so widely across economic environments that it is difficult to generalize from industry-specific studies. A related possibility is that the union coefficient in the production function crudely tracks the union–nonunion wage differential. An additional limitation is the overly restrictive assumption of the Cobb–Douglas functional form and of neutral, disembodied technology. Data deficiencies provide still further limitations. In the aggregate studies, union and nonunion sectors are assumed to have identical production functions ($\alpha_u = \alpha_n$). The reliability of the production function test also depends on the ability to control for important inputs in the production process other than union status and quantities of labor and capital. Specifically, union and nonunion establishments may differ systematically in the quality of unmeasured organizational factors (e.g., managerial supervision and the quality of labor relations) such that “firm effects” are not independent of union status.

Perhaps the most serious criticism of the union productivity test is that of selectivity. Union firms facing higher wage rates must be more productive if they are to survive in the very long run. Hence, the productivity effect is not being measured across a representative sample of firms; rather, only those union firms that have survived by increasing productivity sufficiently to offset higher union wages are observed. Measurement of union productivity differentials among surviving firms thus biases upward the estimated productivity effect of unions on a representative firm. The importance of the limitations outlined above varies significantly with the particular study or application. Addison and Hirsch (1989) interpret the extant evidence and conclude that no compelling case exists for a statistically or quantitatively significant union productivity effect in general, positive or negative. In this paper, it is union effects on both productivity levels and productivity growth that are of interest.

In order to examine union effects on productivity, the following variant of the Brown–Medoff Cobb–Douglas production function [Eq. (5)] is estimated:

$$\ln(\frac{VA}{L})_{it} = \sum \beta_{vk} X_{Vkit} + \alpha \ln(K/L)_{it} + (1 - \alpha)(c - 1)UN_i + \epsilon_{vit},$$

(8)

where subscript $V$ signifies vectors attaching to Eq. (8). The log of value added per employee in firm $i$ and year $t$, $\ln(\frac{VA}{L})_{it}$, is a function of the log of the capital–labor ratio, $\ln(\frac{K}{L})$, and firm-level union coverage, UN. The vector $X_{Vk}$ includes the log of labor, $\ln(L)$; the log of the R&D
stock, ln(R&D-STK); and year and industry dummies. These two vectors of dummies are important because labor productivity varies considerably across industries and over time, and unionization is not randomly distributed across industries. A positive (negative) coefficient on UN implies that union establishments are more (less) productive than similar nonunion establishments, that is, that \( c > 1 \) (\( c < 1 \)).

Estimates from Eq. (8) are presented in Table 3, for specifications with and without inclusion of industry dummies, and separately for the sample with direct R&D stock measurement and for the larger sample including R&D stock estimates for some firms. The coefficient on firm union coverage status is negative and significant in all specifications. Estimates from both samples indicate that unionized companies have approximately 8% lower productivity than nonunion companies with identically measured inputs. The estimated union effect is significantly more negative when industry dummies are excluded (consistent with the Brown–Medoff finding that unions are highly organized in less productive industries). These negative estimates are notable, particularly since many of the econometric biases inherent in the Brown–Medoff methodology, as discussed above, lead to upward biased estimates of the union effect.\(^{25}\)

In results not presented, the union–productivity relationship was examined further by interacting UN with the other right-hand side variables (but not the year and industry dummies). The lower productivity of unionized firms is found to be associated with significantly lower output elasticities with respect to physical and R&D capital. The

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
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<tr>
<td>UN</td>
<td>-0.140</td>
<td>-0.083</td>
<td>-0.130</td>
<td>-0.085</td>
</tr>
<tr>
<td>(10.91)</td>
<td>(6.35)</td>
<td>(11.31)</td>
<td>(7.24)</td>
<td></td>
</tr>
<tr>
<td>ln(K/L)</td>
<td>0.238</td>
<td>0.191</td>
<td>0.259</td>
<td>0.255</td>
</tr>
<tr>
<td>(26.74)</td>
<td>(15.84)</td>
<td>(35.78)</td>
<td>(27.34)</td>
<td></td>
</tr>
<tr>
<td>R&amp;D-STK</td>
<td>0.120</td>
<td>0.078</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(21.22)</td>
<td>(11.66)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&amp;D-STK(\text{est})</td>
<td></td>
<td></td>
<td>0.106</td>
<td>0.052</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(22.52)</td>
<td>(9.11)</td>
</tr>
<tr>
<td>ln(L)</td>
<td>-0.137</td>
<td>-0.103</td>
<td>-0.112</td>
<td>-0.069</td>
</tr>
<tr>
<td>(18.02)</td>
<td>(12.75)</td>
<td>(18.48)</td>
<td>(11.01)</td>
<td></td>
</tr>
<tr>
<td>IND</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>YEAR</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R²</td>
<td>0.442</td>
<td>0.595</td>
<td>0.448</td>
<td>0.575</td>
</tr>
<tr>
<td>n</td>
<td>2304</td>
<td>2304</td>
<td>3146</td>
<td>3146</td>
</tr>
</tbody>
</table>

---

\(^{25}\)Dependent Variable is ln(VA/L). |t| in parentheses.
explanation for these differences is not entirely clear. Lower output
elasticities with respect to physical capital and R&D are consistent,
however, with the rent-seeking model presented earlier (in particular,
see Baldwin, 1983), in which union companies invest in "second-
best" tangible and intangible capital to mitigate union wage demands.
Union firms also are more likely to be in mature industries with older
and less productive capital stocks. Although the capital and R&D
variables are age-adjusted stock measures, these adjustments may not
fully account for quality differences in the capital stock.

Finally, it should be noted that there are indirect as well as direct
effects of unions on productivity. Both physical and R&D capital in-
crease output and, as seen in the previous section, unionized firms
invest less than nonunion firms in both types of capital. Hence, union
firms in our sample have lower value added per worker not only
because of direct union effects in the workplace, but also because
tangible and intangible capital stocks are lower than they would be in
the absence of collective bargaining coverage. An estimate of union-
ism's total effect on productivity would require that we estimate union
effects on employment and the capital–labor ratio. The partial indi-
direct effect of unionism on productivity due to lower R&D investment
can be crudely approximated, however. If high union firms have R&D
capital stocks 12% smaller than otherwise similar low union firms [due
to steady-state R&D investment expenditures 12% lower, as seen in
Eq. (2)], than a union firm would have a labor productivity an addi-
tional 0.6 to 0.9% less than a nonunion firm (based on coefficients on
R&D-STK of 0.052 and 0.078). This indirect effect of unionism on
labor productivity, thus, appears to be relatively small in magnitude.

The effects of unionization on productivity growth are examined
using a variant of Eq. (7). Rather than compute changes in total factor
productivity, "partial" productivity growth rates (Griliches, 1986) are
calculated as the growth rate of deflated value added, minus the growth
rate of employment times labor's share of total cost. The growth rate of
capital is included on the right-hand side of the equation. Such a
specification is appealing in data sets where capital's share is difficult
to estimate accurately, and it allows for a straightforward estimation of
unionism's indirect effects on productivity growth via changes in capi-
tal and R&D investment. Thus, the productivity growth equation
takes the following general form:

$$\rho_{it} = \sum \beta_{pk} X_{pkit} + \phi U N_{i} + e_{pit},$$

(9)
where subscript $\rho$ signifies vectors attaching to Eq. (9), and $\rho_{it}$ is productivity growth, as just defined, by firm i over period t (here representing average annual 4-year growth rates for 1970–1974 through 1976–1980, measured by the difference in log values, divided by four). The vector $X_{\rho}$ includes average annual growth rates in the capital stock, the R&D stock, and employment over period t; firm size (measured by the average number of employees over the period); average industry growth rates, import shares, and energy cost shares; and year and industry dummies. The direct effect of unions on productivity growth is approximated by the coefficient on UN; indirect effects will take place via union effects on capital and R&D investment. Because we measure unionization only at a single point in time, we are unable to relate changes in productivity to changes in union coverage.

Table 4 presents regression results for the productivity growth equations, with and without inclusion of industry level variables and dummies. Annual partial productivity growth, $\rho$, averaged 1.4% among our sample of company-years. Productivity growth is positively

| Table 4. Productivity Growth Equations—Regression Results$^a$ |
|-------------|-----|-----|
| **Variable** | **(1)** | **(2)** | **(3)** |
| UN | $-0.021$ | $-0.013$ | $-0.006$ |
| | $(8.98)$ | $(5.39)$ | $(2.27)$ |
| $d\ln(K)$ | $0.075$ | $0.111$ | $0.154$ |
| | $(3.72)$ | $(5.66)$ | $(7.95)$ |
| $d\ln(L)$ | $0.224$ | $0.189$ | $0.181$ |
| | $(10.75)$ | $(9.32)$ | $(9.26)$ |
| $d\ R&D-STK^{est}$ | $0.029$ | $0.025$ | $0.020$ |
| | $(3.42)$ | $(3.02)$ | $(2.55)$ |
| $R&D-STK^{est}$ | $0.002$ | $0.001$ | $0.003$ |
| | $(3.49)$ | $(1.07)$ | $(2.10)$ |
| ENERGY/VA | $-0.162$ | $-0.039$ |
| | $(9.32)$ | $(1.35)$ |
| $\ln(L)$ | $-0.0003$ | $-0.0017$ |
| | $(0.26)$ | $(1.21)$ |
| I-GROWTH | $0.0016$ | $0.0009$ |
| | $(7.96)$ | $(4.17)$ |
| I-IMPORT | $0.027$ | $-0.025$ |
| | $(1.90)$ | $(1.60)$ |
| IND | No | No | Yes |
| YEAR | Yes | Yes | Yes |
| $\bar{R}^2$ | $0.278$ | $0.335$ | $0.402$ |
| n | 1932 | 1932 | 1932 |

$^a$Dependent variable is annual 4-year growth rate, $\rho_{70-74}$ through $\rho_{76-80}$. $|t|$ in parentheses.
and significantly related to the growth rates of physical capital, employment, and R&D. In regression models without industry variables, \( \rho \) is *substantially* lower among union firms.\textsuperscript{27} Point estimates of the UN coefficient suggest that union companies realized productivity growth 2.1 percentage points lower than nonunion companies, far exceeding the growth rate’s sample mean.

Once industry-level variables and two-digit dummies are included, however, the estimated direct union effect on productivity growth is reduced sharply. The union coefficient changes from \(-0.021\) to \(-0.013\) when industry-level variables are added, and to \(-0.006\) with the further addition of industry dummies. Our results strongly suggest that much of the negative relationship found in previous studies between productivity growth and unionization primarily captures industry-level effects. Union firms are realizing significantly slower productivity growth than nonunion firms; however, slower growth may not result primarily from direct effects of unions in the workplace. Rather, highly unionized firms are more likely to be in industries with high energy costs, slower sales growth, and in broad (two-digit) industry categories with slow growth.\textsuperscript{28} The magnitude of the estimated direct union effect is hardly trivial, however; the coefficient of \(-0.006\) implies that high union firms have productivity growth 0.6 percentage points slower than similar nonunion firms, relative to a mean growth rate of 1.4%.

In addition to the direct union effects on productivity growth examined above, union coverage may have an indirect effect of lowering productivity growth by decreasing new investment in physical capital, R&D, and other forms of innovative activity. For example, unions decrease productivity growth rates by lowering the steady-state level of R&D stocks, although calculations of this effect based on parameter estimates from Eqs. (2) and (9) suggest the magnitude of this effect is quite small. (Note that union firms with lower R&D expenditures and stocks need not have differential growth rates in their stocks.)

**V. QUALIFICATIONS AND INTERPRETATION**

The evidence presented in this paper provides compelling evidence that there are large and significant differences in economic performance between union and nonunion firms. What is not clear from extant evidence is the degree to which unionization is the causal force in these empirical relationships, and the exact routes through which union or-
ganizing and bargaining power affect firm (and industry) performance. We have proffered a model of union rent seeking through which union effects on profitability, investment behavior, and productivity growth are closely related and can be analyzed in a unified framework. Empirical evidence is broadly supportive of this framework. Yet, numerous reservations attach to this evidence and it should be interpreted not as conclusive but, rather, as tentative and suggestive support for the rent-seeking model.

Although space does not allow detailed examination of theoretical or econometric qualifications attaching to the analysis, several reservations and concerns warrant discussion. The most serious caveats (although hardly specific to this study) are the endogeneity of unionism and simultaneous determination of key variables in the model, the error structure of the time-series cross-section estimation, selectivity bias engendered by an inability to observe nonsurviving firms, the difficulty in separating firm-level and industry-level union effects, and the appropriateness of using R&D as a proxy for innovative activity.

Firm-level union coverage is treated as an exogenous variable in this paper, even though it is certainly the case that unionization is not randomly distributed across firms and industries. It would be technically feasible to account for the endogeneity of key variables or to estimate a full system of simultaneous equations (or, in a more limited fashion, to test for exogeneity using Hausman-type specification tests). Given the limitations of available data and theory, however, we have little confidence in such efforts. We have no firm-level information that would help us estimate a reduced form union equation, although industry-level variables (at the three-digit level) are available on work force characteristics. And while all equations could be trivially overidentified by excluding selected variables or through the estimation of nonlinear relationships (or through the use of stocks in one equation and flows in another), selection of instruments would be largely arbitrary since reasonable arguments can be made that almost any variable affecting, say, R&D expenditure, would also affect profitability or capital investment.

These remarks are not intended to argue that simultaneity bias is not important but, rather, that superficial treatment of simultaneity is unlikely to be helpful. That being said, we are confident that the qualitative relationships found in this paper are not a statistical artifact or the result of simultaneity bias. In fact, biases that we can identify suggest that union effects on economic performance may be underestimated. Unions are more likely to be successful in organizing firms with the
largest potential profits or quasi-rents; hence, the negative union coefficient in the rate of return equations may understate the true negative impact of unions on earnings (Voos and Mishel, 1986; Hirsch and Connolly, 1987). By extension, we may then be underestimating the indirect effect that unions have on R&D and new capital investment through their effect on earnings.

A bias in the opposite direction results from simultaneity between R&D and earnings, each having a positive effect on the other. Hence, the coefficient on \( \pi \) in the R&D investment equation may be biased upward and, by extension, the indirect effect of unions on R&D may be estimated with bias (it is conceivable that these biases roughly offset each other). Regardless of the relative sizes of these opposing biases on unions' indirect effect on investment, the conclusion that unions have a direct negative impact on investment continues to hold, since union coefficients in the investment equations were negative and significant, regardless of the inclusion of \( \pi \). Moreover, simultaneity bias between capital and unionization (unions are more likely to organize in capital-intensive industries), likely results in an underestimate of the negative effect of unions on capital investment.

An econometric problem inherent in estimation of panel data is that error terms are serially correlated across time for given firms. Thus, the standard errors presented in the paper are biased downward. Alternative pooled estimation methods were not used here. Separate estimation of all models by year eliminates serial correlation, but sharply reduces sample size. Results from yearly regressions produced moderate to substantial year-to-year variability in the union coefficients, with much larger standard errors attached to these coefficients. An alternative method would be the estimation of two-way fixed-effects models including dummy variables for each firm as well as year. Unfortunately, inclusion of firm dummy variables would introduce perfect collinearity with the union variable since firm unionization does not vary across time in these data.

Further qualification of our results stems from the inherent selection bias engendered by the fact that only firms that survive unionization are observed. If unions impact negatively on profits, investment, and growth, those firms able to partially offset union effects through higher productivity or special firm-advantages are more likely to survive than the average firm that becomes unionized (and, as discussed above, successful firms are more likely to become organized). For this reason, estimated negative effects of unions on profits, investment, productivity, and productivity growth are likely to understate average union
effects, since firms most adversely affected by unions are least likely to have survived and be included in any sample of firms.

A final statistical caveat concerns the difficulty in distinguishing between union and industry effects. Highly unionized firms are more likely to be in less profitable, slower growing industries with lower rates of new investment and productivity growth. Regression results presented in this paper include specifications with and without two-digit industry dummies and, typically, estimated union effects decrease following accounting for industry differences. In order not to overstate the effect of unions on economic performance, conclusions expressed in the paper are based on regression results from specifications with dummies included. We may be understating unionism’s true effects by including dummies, however, since some industry differences in performance are likely to result from differences in industry-level union coverage.\(^{29}\) The presence of both firm- and industry-level union coverage data potentially can enable us to distinguish among these effects, but such analysis awaits future study.

A rather different concern is that expenditures on R&D and estimated R&D stocks may be inadequate proxies for the much broader category of investment—innovative activity—for which we would like to make inferences. While evidence in this area is limited, that which exists suggests that the union effects we have uncovered apply to innovative activity broadly, and not just to R&D. In work not shown in this paper, use of patent stock data instead of R&D (i.e., an output rather than an input measure of innovative activity) produced highly similar inferences about union effects. In other studies, Hirsch and Link (1987) analyze survey data from a sample of small- and medium-sized firms and they find that unionized firms rank product innovative activity as being significantly less important in their strategy and performance than do similar nonunion firms. Also, Acs and Audretsch (1987) find that both small- and large-firm innovations (defined based on measured outcomes independently of R&D or patents) have been significantly lower in more highly unionized industries.

Finally, it should be noted that inferences about union effects on economy-wide efficiency cannot be drawn directly from our evidence. Even though unions significantly distort resource allocation at the firm level, their economy-wide effect may be less significant. For example, lower new capital investment among unionized firms may be offset by higher capital investment elsewhere in the economy. If resources could costlessly flow to their highest valued use, there would be little effect of unions on economy-wide efficiency. But unions could not then have
the significant long-run effects on firm profitability and other aspects of performance that have been observed. Given that unions have some degree of monopoly bargaining power, and shifting of resources from union to nonunion environments occurs slowly, union distortions at the firm level necessarily translate into some degree of inefficiency economy-wide.

VI. SUMMARY

This paper has provided evidence in broad support of the union rent-seeking model. Building on previous theoretical work, a repeated bargaining model is presented wherein both cooperative and noncooperative outcomes result in lower levels of R&D and capital investment among union companies than among similar nonunion companies. A key assumption of these models is that the time horizon for a union is shorter than investors’ horizon over which some forms of long-lived capital are evaluated. Unions appropriate some portion of the quasi-rents that make up the normal return to long-lived capital. Firms rationally reduce their investment in vulnerable forms of physical and innovation capital, due both to the union “tax” on investment returns, and because current firm earnings, which provide a relatively lower cost source of funding, are reduced. Decreased investment in physical and innovation capital subsequently has an impact on productivity and rates of productivity growth. These “indirect” effects of unions on productivity and productivity growth are distinct from any “direct” effects unions may have on productivity (or technical efficiency) in the workplace.

Empirical evidence on the union rent-seeking model is based on an unbalanced 1970 to 1980 panel of 315 firms for which firm-level union coverage data are available for 1972. Examined are union effects on profitability, investment behavior, productivity, and productivity growth. Evidence of large and significant differences in the economic performance of union and nonunion firms is found. Unionized companies are found to have lower investment in R&D and capital investment than their nonunion counterparts. The union effect on investment is comprised of two components—a direct effect resulting from the union tax or appropriation of quasi-rents emanating from long-lived capital, and an indirect effect due to more costly financing owing to lower earnings. Indirect effects appear to be important, accounting for
about one-quarter of the total union effect on R&D investment and half of the effect on capital investment.

The direct and indirect effects of unions on productivity and productivity growth are then examined. Previous estimates of union effects on productivity have varied considerably. For this sample of firms, unionization is associated with about 8% lower productivity, given levels of inputs. Output in unionized firms is even lower if one considers the indirect effect of unions in lowering the long-run stocks of physical capital and R&D, although these indirect effects appear relatively modest. Finally, attention is focused on the effects of unions on productivity growth rates from 1970–1974 through 1976–1980. Union firms exhibit substantially slower productivity growth over this period, but most of this slower growth results from highly unionized firms being in four-digit industry groups with slower sales (demand) growth and higher energy costs, or in broad two-digit industry groups with slower productivity growth. Even after controlling for these industry and firm effects, however, union companies are found to have exhibited slower growth than nonunion companies. We are unable to reliably estimate the indirect effects of unionization on productivity growth.

The intent of this paper has been to draw attention to the potentially important role that labor unions have on the economic performance of firms. Recent theoretical and empirical research strongly suggests that unionization has had a substantial impact on firm profitability, investment behavior, innovative activity, productivity, and productivity growth during the 1970s. Yet the relationship between collective bargaining and firm performance still has received only limited attention from researchers. To date, both the magnitude of union effects and the precise routes through which unions impact economic performance are not well understood. Further study is clearly warranted, although substantial improvement in our understanding of what unions do will depend crucially on the development of improved data sets.30

Such efforts should prove fruitful. Private-sector unionism has declined sharply in recent years and nonunion work environments have increasingly become the norm for much of the work force and in most sectors of the economy. Indeed, this transformation in U.S. industrial relations may be in part a response to the relatively poor economic performance of union companies. Future research can improve not only our knowledge of unionism's impact on firm performance, but also our understanding of the complex relationship between the appropriability of investment returns, innovative activity, and subsequent productivity growth.
## APPENDIX: DEFINITIONS OF VARIABLES INCLUDED IN REGRESSION MODELS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN</td>
<td>Dummy variable equal to 1 if proportion of firm's workers covered by a collective bargaining agreement in 1972 is greater than or equal to 0.10, and 0 otherwise.</td>
</tr>
<tr>
<td>(\pi_k)</td>
<td>Gross rate of return on capital; gross cash flows divided by the value of the net inflation-adjusted capital stock (Cummins et al., 1985).</td>
</tr>
<tr>
<td>(\ln(\text{R&amp;D}))</td>
<td>Natural log of R&amp;D expenditures in 1972 dollars. Deflator shown in Cummins et al. (1985).</td>
</tr>
<tr>
<td>(\ln(\text{R&amp;D-STK}))</td>
<td>Natural log of R&amp;D stock in millions of 1972 dollars; calculated based on 15% depreciation rate.</td>
</tr>
<tr>
<td>(\ln(\text{R&amp;D-STK}(-1)))</td>
<td>Natural log of (R&amp;D stock minus annual expenditures), in millions of 1972 dollars.</td>
</tr>
<tr>
<td>(\ln(\text{INV}))</td>
<td>Natural log of annual investment, in millions of 1972 dollars.</td>
</tr>
<tr>
<td>(\ln(\text{K}))</td>
<td>Natural log of net inflation-adjusted capital stock in millions of 1972 dollars (Cummins et al., 1985).</td>
</tr>
<tr>
<td>(\ln(\text{K}(-1)))</td>
<td>Natural log of (capital stock minus annual investment), in 1972 dollars.</td>
</tr>
<tr>
<td>(\ln(\text{L}))</td>
<td>Natural log of employment, in thousands.</td>
</tr>
<tr>
<td>(\ln(\text{K/L}))</td>
<td>Natural log of net capital stock per employee, in millions of 1972 dollars.</td>
</tr>
<tr>
<td>(\ln(\text{VA/L}))</td>
<td>Natural log of value added per employee, in millions of 1972 dollars. Value added estimated by (sales - cost of goods + labor costs). Where labor cost not available, it is approximated by ([\text{employees} \times \text{(average industry compensation)}(1 + 0.25 \text{COV})]). See footnote 21.</td>
</tr>
<tr>
<td>(\rho_{70-74/76-80})</td>
<td>Partial productivity growth, calculated as the average annual growth rates in value added during 1970–1974 through 1976–1980, minus average annual growth rates in employment times labor's share of total costs (see above).</td>
</tr>
<tr>
<td>I-GROWTH</td>
<td>Average percentage growth rate in real industry shipments over the previous four years in firm's primary four-digit industry. Shipments deflated by industry-specific price indices.</td>
</tr>
<tr>
<td>ENERGY/VA</td>
<td>The proportion of energy costs to value added in the firm's primary four-digit industry.</td>
</tr>
</tbody>
</table>

## ACKNOWLEDGMENTS

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NOTES

1. Among others, see the articles in Griliches (1984) and, more recently, Levin et al. (1987).

2. For comprehensive reviews of the literature on union effects, see Freeman and Medoff (1984), Hirsch and Addison (1986), and Addison and Hirsch (1989). Lewis (1986) focuses exclusively on estimation of union wage effects, while Kochan et al. (1986) describe the recent transformation in U.S. industrial relations. For a recent analysis of U.S. labor law, see Flanagan (1987).

3. For a recent dialogue on union decline, see Freeman (1988) and Reder (1988).

4. There are, in fact, multiple parties to the bargaining process: management, shareholders, union leadership, and the rank-and-file. It is generally assumed that management (the agent) attempts to maximize shareholders' (principals') wealth. It is also reasonable to assume that union leaders (or agents) accurately represent the interests of the rank-and-file (principals), with union goals being most influenced by members with preferences close to the median. Incentive compatibility between principals and agents effectively reduces the number of bargaining parties to two—the union and the firm.


6. Stated alternatively, capital has fixed costs and is relationship specific. Once in place, returns to that capital exceeding its opportunity costs provide quasi-rents; these quasi-rents provide what are largely normal returns to prior R&D and capital investment.

7. We do not consider in this paper the possibility of opportunistic behavior leading firms to appropriate worker rents. Firms may appropriate worker rents associated with firm-specific skills by paying wages lower than lifetime marginal products, reneging on pension promises, and the like. Healthy firms are unlikely to do so, however, because the loss in reputation capital will make it more difficult (costly) to attract and retain future workers. Declining firms may be more likely to engage in opportunistic behavior. For discussion of possible firm appropriation of the returns to firm-specific training, see Williamson et al. (1975), Klein et al. (1978), and Crawford (1988).

8. The implicit assumption in Baldwin's model is that the contract wage is similar across all union plants and the firm is free to vary employment. Hence, union wage demands based on productivity in a firm's efficient plants would lead to layoffs or shutdowns at the firm's inefficient plants.

9. The union could make its wage commitment credible by offering a "bond" or "hostage" that it agrees to forfeit in the event it reneges on its promise. The bond must be held by a third party, since if it were held by the firm (say, in the form of promised pension payments), the firm would have incentive to default on the bond and could not make a credible commitment to the union (such commitments are credible in the case of infinitely repeated bargaining). Bonds held by third parties are not observed in practice.

10. Note the somewhat surprising conclusion that union wage demands (and the union–nonunion wage differential) may increase in a declining industry with long-
lived specific capital. For similar arguments along these lines, see the analysis of the
U.S. steel industry by Lawrence and Lawrence (1985).

11. This is the strong efficiency case (Brown and Ashenfelter, 1986) referred to
previously. Strong efficiency implies that the firm's employment level is a function of
the opportunity cost wage, and not the "own" wage as implied by settlements on the
labor demand curve. This prediction has formed the basis for several empirical tests of
on-the-demand curve versus off-the-demand curve bargaining models.

contracts will in general lead to inefficient contracts and underinvestment in relation-
specific fixed-cost capital. The argument in this paper is more fundamental: even if
efficient (jointly maximizing) contract settlements are obtained, there will be lower
investment by union than by similar nonunion companies.

13. Profit sharing, based on current accounting profits rather than stock value,
does not make union members more future oriented (although it may increase labor
productivity).

14. For evidence that R&D "Granger causes" capital investment, but investment
does not Granger cause R&D, see Lach and Schankerman (1987). Most company-
financed R&D expenditures are for product innovations (Link and Tassey, 1987). Of
course, product innovations by companies selling intermediate products make up the
major source of process innovations to purchasers.

15. Unions are also likely to capture profits associated with market power in
product markets. For a detailed examination of this issue, an analysis of specification
of profit models measuring union effects, and references, see Hirsch and Connolly

16. The union data were kindly provided by David C. Hershfield, who developed
the figures from data collected in a 1972 survey by the Conference Board.

17. These figures compare to union coverage figures for manufacturing for 1968–
1972, calculated from the BLS Expenditures for Employee Compensation (EEC)
surveys, of 46% of the total work force and 61% of production employees; and
estimates of union membership, calculated from the 1973–1975 May Current Popula-
tion Surveys, of 37 and 49%, respectively (Freeman and Medoff, 1979). Differences
among these measures results in part from the secular decline in private sector union-
ization during this period.

18. Discussion and documentation for the data set, named the R&D Master File,
are provided in Bound et al. (1984), Cummins et al. (1985), and Body and Jaffe (no
date). The data were kindly provided by Zvi Griliches.

19. Rates of return on sales exhibit a similar, although less marked, pattern. As
expected, rates of return on equity are approximately equal across classes (since equity
values adjust to differences in expected earnings)—21.3, 20.4, and 20.0 for the low,
middle, and high union categories, respectively.

20. Average R&D/S is computed only for firms reporting positive R&D; non-
reporting firms are excluded. For early years in our sample, many nonreporting firms
are in fact R&D active. For most years, however, nonreporting firms typically are not
R&D active. A identical pattern with respect to union coverage is evident when
nonreporting firms are assumed to have zero R&D investment. See Bound et al. (1984)
for a detailed discussion of nonreporting of R&D.

21. Value added is measured with error owing to the absence of data in Compustat
on the cost of materials. The Compustat item "cost of goods" measures materials and
production costs, including all labor costs. In order to calculate value added, firm labor costs must be added back in. But only about 40% of the firms in our sample had direct measures of labor compensation and pension costs. For the remaining firms, labor costs were estimated by multiplying firm employment times average industry compensation, the later being inflated by 0.25 times COV in order to reflect the higher labor costs in union firms (were this not done there would have been spurious negative correlation between unionism and estimated value added). The 0.25 COV adjustment factor was arrived at through experimentation on the sample of firm-years with actual labor and pension costs. For these firms, mean measurement error (defined as the difference between “actual” value added and “estimated” value added) was uncorrelated with union coverage. Thus, measurement error in value added should not result in coefficient bias in subsequent productivity level or productivity growth equations.

22. Constructed for estimation in this paper were predicted R&D expenditure and stock variables equal to the actual values for those firms with reported positive values, and equal to predicted values for companies with zero or unreported values, but with patent stock information. Predicted R&D variables are calculated based on coefficient estimates from auxiliary regressions of R&D on the patent stock, patent stock squared, patent stock cubed, and year and industry dummies. The log of the R&D stock regression had a sample size of 2417 and an R² of 0.73. The log of annual real R&D expenditure regression had a sample size of 1949 and an R² of 0.68.

23. Full regression results from the profit equation are available on request. Similar results are obtained if the market valuation measure, Tobin’s q, is used as the profits measure. The profitability equation included variables measuring the R&D stock divided by sales, firm size, capital intensity, industry growth, industry concentration, import intensity, and industry and year dummies. The estimated union effect on profit is smaller (i.e., less negative) when the sample was restricted to include only firms with reported R&D expenditures (and thus calculable R&D stocks).

24. Williamson et al. (1975) discuss a similar workplace environment, which they characterize as one of “ideosyncratic exchange.” Interestingly, they do not explicitly discuss unions, whereas Freeman and Medoff, by contrast, give little attention to the possibility of a nonunion solution to the public goods problem. Surveys of the productivity literature, with interpretation, are provided in Freeman and Medoff (1984), Hirsch and Addison (1986), and Addison and Hirsch (1989).

25. Unlike industry-level analyses, firm-level analysis may impart little upward bias to value added due to the price effects of union wage increases, since individual firms are unlikely to be able to pass through cost increases to consumers. Union firms’ inability to pass through cost increases is evinced most directly by their significantly lower profit rates.

26. On theoretical grounds, unionism unambiguously reduces employment. Bronars and Deere (1987) provide explicit evidence showing that firms respond to union representation elections by lowering employment.

27. When the equation is estimated for the smaller sample with complete R&D stock information, the R&D coefficient is larger, but results with respect to union coverage are not affected.

28. Slower growth at the two-digit industry level may be related in part to industry-wide unionization. Unfortunately, the data are not rich enough to distinguish clearly between firm-level and industry-level union effects.

29. Of course, it might also be argued that the two-digit level is too broad a
category for industry dummies and that our firm-level union coverage variable is really capturing industry-specific differences in performance within two-digit industry categories.

30. The author is currently assembling a large data set with firm-level union coverage information.

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